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BOOK REVIEWS

Molecular Clouds in the Milky Way and External Galaxies (Lecture Notes in Physics; Vol 315)

(Proceedings of a Symposium held at the University of Massachusetts in Amherst, Massachusetts, November 2–4, 1987)

edited by R L Diokman, R L Snell and J S Young

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The volume contains invited and contributed papers presented in a three-day symposium which was attended by more than 200 eminent astrophysicists from all over the world. The papers presented cover a wide range of interest and is divided into four sections, namely, Molecular Cloud Properties, Molecular Clouds and Galactic Structure, Extra Galactic Studies and Technical Avenues to the Future. Papers in these sections are suitably subdivided. In the first section which includes a very large number of papers in which the properties of molecular clouds of specific interest are considered, namely,. temperature and densities, cloud sizes and masses, magnetic fields, chemistry, fragmentation and structure, and star formation and outflows. In the second section papers are subdivided into cloud evaluation and galactic surveys The third section includes papers on molecular content of galaxies and spiral structure The fourth and the final section contains three papers entitled, 'A 3 mm Imaging Array for Astronomical Spectroscopy', 'The Design of Millimeter Array' and 'The Colonge Observatory for submm and mm-Astronomy'. Thus the volume includes papers in various aspects of modern interest in the field of molecular clouds in the Milky Way and external galaxies.

For understanding the structure and evolution of an intermolecular cloud, its temperature and density should be known. These two parameters depend on a wide variety of microscopic and large-scale processes and are elaborately discussed in the volume.

To consider thermal equilibrium in the interstellar molecular clouds, one should consider the heating of clouds caused by the cosmic ray, UV photoelectric effect, ion-neutral slip, turbulence dissipation and collision with dust. The main cooling process involves line emissions of CO, C, H_2O and O_2.

The importance of CO as a probe to ISM is due to the following :

(i) CO is one of the most abundant molecule in the ISM.

(ii) Its rotational levels are excited in the wide range of temperatures and densities.

(iii) The radiative transitions extend the spectrum from millimeter to infrared.

(iv) The lowest J transition in the millimeter wave range is easily excited so that even cold gas can be seen in CO.

Different techniques are used for determining the density of clouds. Depending upon the scale of measurement relative to the entire cloud, the methods of determining density have been classified into macro-, meso- and micro-. The macro technique which is based on virial equilibrium is inapplicable to dark cloud with smaller mass ($< 10^4$ solar mass), for example, to clouds in which materials are outflowing from young stellar objects. In meso method, the column density determined along a particular line of sight and the averaging perpendicular in the line of sight is restricted to the projected area of the telescope beam. In the microscopic scale of measurement, local gas density is determined.

The knowledge of mass of hydrogen molecular content of a cloud is essential for understanding precisely the star formation process. Unfortunately, due to various reasons it is very difficult to make a direct observation of interstellar molecular hydrogen by a usable probe starting from UV Lyman down to rotational transition. For indirect observation of H mass, the photometric extinction measurements, dust emission technique and integrated CO intensity as a secondary column density tracer are important. The first one is a modified version of star count. The second method utilises the knowledge of gas-dust ratio and its relation to IR optical depth and colour temperature obtainable from 'skyflux' map produced by IRAS Mission.

It is pointed out in the volume the importance of magnetic field to star formation, which is of significance to modern astrophysics. Previously star formation was considered from knowledge of density, temperature, chemical composition and kinematics of molecular clouds. It has now become clear that the magnetic field plays an important and crucial role for star formation process including formation of clouds via the Parker instability which includes all fields including magnetic field. For determining the existence and strength of magnetic field within molecular clouds, polarisation of IR radiation and Zeeman splitting are used as main probes. The energy retained by the magnetic field within a molecular cloud is comparable with the energy due to the gravitational field.

In the subchapter 'Chemistry', the investigators have dealt with various kinds of complex molecules, their formation mechanisms and rates under different average thermodynamical conditions and also their abundance ratios in different cloud complexes within the same and different galaxies.

Observations showed that most of the galaxies have a spiral structure which is consistent with other scenarioes with the possibility that the galaxies were formed in a state of rotational instability within a GMC. It is also observed that star formation efficiency, which is measured through the ratio of CO luminosity to H_2 mass is enhanced in the spiral arms of galaxies. Cloud collision may yield such rotation instability that give rise to a spiral structure. There are number of evidences that cloud collisions occur in many cloud complexes.

It is pointed out in the volume that a large number of eminent astrophysicists are

engaged in observing through radio telescopes the extent and formation of stars, galaxies and the universe as a whole. However, our knowledge still remains in an unsatisfactory state.

As trophysicists are searching for new technical avenues and feel that with invention of instruments with higher resolution, a closer approach to truth in the field can be made.

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Beyond the Atom : The Philosophical Thought of Wolfgang Pauli
K V Laurikainen
Springer-Verlag : Berlin-Heidelberg-New York-London-Paris-Tokyo-Hong Kong, 1988
xix + 234 pages ; 10 figures, price DM 68,00 (soft cover) ; ISBN 3-540 -19456-8

The book entitled 'Beyond the atom' by Prof K V Laurikainen unfolds a new world of philosophical thought of Wolfgang Pauli. This can aptly be regarded as a philosophical exegesis on the Austrian physicist, a central figure among the founders of Quantum Physics, whom Einstein called his 'Spiritual son' and who was Heisenberg's critical genius.

Pauli's interest in philosophy and history of ideas was strong ever since his school days. His discourse with Niels Bohr on the epistemological aspects of atomic theory and reality of the atomic world deepened his interest. His philosophical publication appeared in fifties in a very compressed form. Prof Laurikainen made a systematic and comprehensive analysis of Pauli's philosophical opinions by bringing out his extensive and open minded correspondence with Prof Markus Fierz 'Prof of Physics, Basel University'.

In his quest for a new conception of reality and causality Pauli made a careful study of the past culminating in study of mysticism of Kepler and of the medieval symbolism. The Kernel of 'Copenhagen School' consisted of Bohr, Heisenberg and Pauli. They contributed to the decisive ideas of Quantum Mechanics. The Copenhagen interpretation became central to Pauli's Philosophy. Pauli's Philosophical and scientific approach were profoundly influenced by his God father Ernst Mach, the well Known German physicist and an exponent of positivistic philosophy.

In his first scientific publication in 1919, Pauli remarked on Hermann Weyl's New gravitational theory which attempted to treat electromagnetic phenomenon on the basis of general relativity. He noted that such a concept is not permissible in a correct theory because we have no way to measure the field strength inside an electron which in itself is the smallest charged body and is used as a test particle for measuring the field – a remark typical of a positivistic philosopher.

Prof Laurikainen in his analysis has shown that Pauli saw deeper than Bohr and Heisenberg in philosophical question and is the most competent and impeccable representative of 'Copenhagen Philosophy'.

Pauli emphasises that reality is irrational it cannot be grasped in its entirely, through pure reason or rational analysis. According to Pauli the sharp distinction between knowledge and faith and between matter and spirit was dangerous. They are complementary to each other in our comprehension of reality.

The 'Appendices' contain four chapters. The first three chapters are particularly fascinating to physicists both from academic and historical point of view. The last chapter contains translation of laters to Fierz, comments and quotation of Pauli from German to English.

Finally, Prof Laurikainen deserves accolades from Physics Community for accomplishing this magnificient task of introducing them with the spiritual intellect of Pauli, christened as 'The conscience of Physics'.

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Review of Finite Element Methods in Linear Ideal Magnetohydrodynamics
(Springer Series in Computational Physics)
by Ralph Gruber and Jacques Rappaz
Springer-Verlag · Berlin-Heidelberg-New York-Tokyo-Hong Kong, 1985
xi + 180 pages ; 103 figures; price DM 110 (Hard cover) ; ISBN 3-540 -13398-4

The emphasis of the book is on the application of the finite element techniques to the ideal magnetohydrodynamic model of toroidal plasma confinement configurations. The simplest description of a plasma is the ideal MHD model in which the plasma is treated as a fluid with high conductivity. In this ideal MHD limit the toroidal tokamak plasma is found to be most unstable and this makes the study of such a model very important for plasma confinement systems. The book presents the study of the equilibrium and stability of toroidal plasmas. This involves the solution of a coupled set of partial differential equations obtained by linearizing the ideal MHD equations in cylindrical geometry. This is a complex mathematical problem which can be solved only by using sophisticated computational techniques. This is where the main contribution of the authors, and of the book, lies. For those who are not familiar with the stability analysis of toroidal systems this book is on the whole a fair introduction to the subject, its complexity and the means to deal with it. And for those who are familiar, the book presents the finite elements techniques for this study and the well known ERATO and Hera codes

Out of the seven chapters in the book, the first two summarizes the background

material, viz. the variational solution of the Sturm-Liouville problem and the ideal MHD model. The third chapter is an appropriately long and elaborate description of the ideal MHD in cylindrical geometry. The discussion on the eigenspectrum uses six test problems – reflecting on the thoroughness of the authors in dealing with this difficult problem. The book will best benefit those fusion theorist with limited exposure to the finite element techniques and their applications. There are adequate details of the techniques on the choice of the basis set of finite elements for the numerical presentation of the exact spectrum when part of it is a continuum.

A discussion of the other numerical codes for tokamak equilibrium and stability, e.g. the Princeton PEST code, in the context of the codes presented in the book would have been valuable. The absence of such a discussion is however justifiable considering the emphasis and size of the monograph. One cannot help feeling that the book is primarily designed for the specialist in MHD theory. In general the book is a valuable compendium for fusion theorists and also for those would like to use finite element techniques to such applications.

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